

Discussion Summary

The workshop program provided opportunities for participants to reflect on and respond to the [information presented](#). Most comments came during “synthesis sessions” at the end of both days. The prompt for these sessions was: What is needed to effectively address Nr in agricultural and ecological systems in the San Joaquin Valley? Comments mostly addressed one of three broad subjects: basic research gaps, information technology development, and policy analysis. This document summarizes the main themes in each category and lists EPA’s follow-up actions from the discussions. For reference, the appendix provides the original comments as captured during the workshop, organized into the same categories.

Research gaps

Participants identified the need for some basic research on the behavior of nitrogen compounds in agricultural settings and several topics addressing the mitigation of nitrogen pollution.

Soil-nutrient-crop interaction

Participants emphasized the need to better understand transformations of organic nitrogen compounds to plant-available nutrients as a function of soil moisture, temperature, soil type, and nitrogen source, primarily in soil but also affecting air and water, to facilitate management of nutrients from organic sources.

Pollution mitigation

[EPA defines “pollutant”](#) as “any substance introduced into the environment that may adversely affect the usefulness of a resource or the health of humans, animals, or ecosystems.” If the substance occurs naturally, the adverse affect occurs when the amount emitted overwhelms the capacity of a system to cycle it and render it harmless. Reactive nitrogen compounds, though essential to plant growth, become pollutants when they accumulate in a geographic area and environmental medium in amounts that exceed the capacity of nature’s nitrogen cycling service to process them. Mitigating nitrogen pollution can involve preventing excessive inputs into the system, characterizing sources of inputs, controlling transport across media boundaries, and removing it from the environment.

Pollution prevention

Concentrations of nutrients in accessible materials – dairy manure being the primary example – provide opportunities to prevent dispersion of excess nutrients into environmental media. Dairy manure is the primary example, and participants suggested the need to develop better processes to capture and manage nutrients in manure and prevent nutrient pollution.

Source characterization

Participants suggested research to characterize more exactly in time and space the sources of ammonia emissions to air and of nitrate releases into groundwater.

Transport

Participants emphasized the need to understand, when applying practices aimed at addressing pollution of one environmental medium, the effects of that intervention on the other media as well, a challenge for media-based organizational structures.

Remediation

Participants indicated a need to better understand natural processes that convert reactive nitrogen back to inert N₂ gas, to support development of more effective engineered processes for removing excess nitrogen from systems.

Information technology development

Participants also expressed strong interests in better information technology to support nitrogen management practices, including improvements in data collection, database format standardization, interface design, and user education.

Data collection

Participants expressed a desire for better electronic sensors – ideally remote (aerial and satellite) sensors – and analyzers for faster measurement of N compounds in the environment

Application development

Participants would like to see N management technology that is easier to use and regularly upgraded, that can access different databases and support micrometeorology and irrigation variables, and that addresses multiple media and incorporates the latest science to support both regulatory compliance and economic optimization

Data management

For data collected for regulatory purposes, participants would like clearly assigned responsibility and adequate funding for database design, management, and maintenance, with databases designed to support multi-user access to shared data to minimize duplicative data collection.

Policy analysis

Although the workshop's intended focus was research, participants also commented extensively on the need for environmental policy analysis. Somewhat arbitrarily categorized, these comments included considerations of approach (e.g., regulatory vs. economic vs. technological), priority, potential benefits, and potential consequences.

Approach

Participants noted that reactive nitrogen is a “wicked” problem, crossing environmental and organizational boundaries and necessitating a holistic approach that challenges specialized disciplines and calls for policy innovation, as opposed to more standard regulatory and economic approaches to the problem. While this social infrastructure develops, some regulation is likely in the near future due to the severity of the problem.

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Relative priority

Participants generally agreed that the first priority, especially in the Tulare Basin, is to provide safe drinking water to all communities, in the most economically and technically feasible way.

Potential benefits

Participants expressed interest in nitrogen management policy that achieves multiple benefits, notably reducing fossil fuel consumption and greenhouse gas emissions while reducing nutrient input costs and environmental costs.

Potential consequences

At the same time, participants commented on the need to evaluate all potential consequences of policy options, including effects on the agricultural economy of the San Joaquin Valley and beyond.

EPA Action Items

The points participants raised during the presentations and discussions at the workshop covered a range of issues and suggested far-reaching institutional changes to address them. Realizing that much of this agenda will take some time to address, EPA will take on the following immediate action items.

Region 9 will attempt to secure funding for and conduct research to address multi-media aspects and agronomic effects of the nitrogen cycle. Some of this is already under way. Specifically, we have secured funding to investigate dry deposition of ammonia in proximity to a dairy to better understand air-to-soil and air-to-water transport of reactive nitrogen. Responding to comments at the workshop, we are applying for funding to investigate mineralization rates of two organic nutrient inputs, dairy manure lagoon effluent and anaerobic digester effluent from dairy manure feedstock, for one cropping/irrigation system. In addition, the workshop prompted a group led by UC Davis researchers to apply for funding to develop a multi-layer risk mapping GIS for the Central Valley that includes ammonia concentrations among other environmental stressors.

Office of Research and Development expects that some of the issues raised at the workshop will make their way into the research roadmap for reactive nitrogen and into the Office of Science and Technology Policy's Nutrient Challenge grant program. Region 9 will continue to participate in the roadmap development process to support consideration of and allocation of research funding to issues important to California agriculture.

Region 9 will continue to update interested stakeholders on the results of this collaborative effort.

Appendix: Categorized comments as captured in workshop notes

Research gaps

Soil-nutrient-crop interaction

- Research results indicate: to reduce N₂O emissions, increase soil organic matter to build up soil structure and porosity and keep soil aerobic
- Need to better quantify nitrogen mineralization rates of organic N by soil type and irrigation system, temperature, and N source material type, to understand how much organic input to apply to satisfy the agronomic uptake rate and what practices nutrition and irrigation practices are effective;
- Also need to better characterize changes in soil attributes and air emissions from organic matter applications
- Need nutrient guidelines for specialized crops (e.g., southeast Asian growers')
- Need to understand crop diversity in CA – timing of uptake, feasible and realistic NUE -- in order to inform regulation.
- Need single protocol that addresses air and water in field trials that meets regulatory requirements for multiple environmental stressors, CO₂ and NO₃, for example.

Pollution mitigation

Pollution prevention

- Need to develop, demonstrate, promote, and implement the use of innovative technologies to capture N from animal feeding operations and transform it into plant-available forms and products valuable to farmers and the fertilizer industry
- Being able to efficiently move N from point of production to point of use as a fertilizer rather than as a pollutant.
- Need to learn to agricultural nitrogen waste management, because cleanup may not be possible in all cases; CalEPA might be able to help.

Source characterization

- Air: need better temporal and spatial definition of sources of ammonia contributions to the atmospheric pool
- Drinking water: need to determine the source of the nitrate contamination – agriculture or septic systems – to determine liability for the cost to remedy them

Transport

- Need to better characterize transfers of reactive nitrogen between environmental pools or media: soil, air, water, products, residues; e.g., manure in soil causing nitrate leaching to ground water
- Where water and air intersect, need to understand where a practice that reduces air emissions might increase water contamination and vice versa. Need to integrate multi-media approach into soil science, e.g., if doing nitrous oxide emissions research, need to also look at percolation of N_r into groundwater. E.g., one study looking at two forms of N and both air emissions and water effects.

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Remediation

- Need to understand natural processes that remove N from groundwater, to learn how to engineer improvements in those processes.
- Need to understand extent of feasibility and strategies for removing N from groundwater.
- Need to better understand denitrification in high-carbon systems like dairy.
- Need to research how to reclaim or clean up nitrate-contaminated aquifers.

Information technology development

- Issues with nutrient management decision support applications – maintenance, data format, education on use, ability to pull from different data sources using a common language that everybody can work in, so make integration possible.
- Practical hurdle: too many apps; commercial hurdle as well.

Data collection

- Need good N₂O analyzers
- Want a sensor to track plant available N in the soil – helps growers to know what to do (potential question/topic for EPA-ORD nutrient challenge)
- Need more field-level tools for quick assessments of N levels in soils.
- Data collection is expensive, subject to vandalism. Can we make better use of remote sensing to get better salinity data for both soil and surface water, as we can for ocean water?
- Funding and implementation for measurement technologies, to improve ability to know how much N is applied and reduce over-application. Need better information about what goes into the system, from a grower perspective.

Application development

- Need automated, micrometeorological applications
- Can decision-support tools support regulatory compliance?
- Need for tools that are useable for growers (web based vs mobile apps); integrate N application and irrigation (rates/amounts/times); maintaining those apps over time
- Linkages between air and water aspects of N management – saw tools for N management for water today but none for air.
- How do we improve nutrient management on site? Regulatory questions aren't necessarily the same as growers' questions.
- Linkages between different researchers and tools, to integrate formats so that producers don't have to negotiate some many. Integrating rather than duplicating efforts, similar formats/software/operating systems
- Issues with decision support apps – maintenance, data format, education on use, ability to pull from different data sources using a common language that everybody can work in, so make integration possible. Practical hurdle – too many apps; commercial hurdle as well.
- Involve non-traditional partners with expertise in software development.
- Funding and implementation for measurement technologies, to improve ability to know how much N is applied and reduce over-application. Need better information about what goes into the system, from a grower perspective.

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- Need better information transfer from researchers to growers, e.g., ability to track N application is a big issue for some growers.
- Could decision-support tools encourage over-application of N due to outdated research?
- Technology transfer to growers getting worse instead of better; need to find new ways to transfer technology, perhaps through crop advisor certification. Need to help ag understand purpose and drivers for regulations, so they know what's going on.

Data management

- Responsibility for database management and data maintenance – should universities house these programs? Funding to maintain FREP data
- Agencies should not make duplicate requests for the same data; should transfer data among agencies and reduce burden on growers.
- Research needs surveys and focus groups for DWR 2013 Water Plan Update point to data issues as primary need; have many databases with questionable data and inadequate metadata. Need standards for distributed systems for interoperable systems (or else one huge, infeasible database).

Policy analysis

Approach

Holistic

- N_r is a “wicked” problem – i.e., complex, due to microbial transformation among N compounds and movement across media boundaries (soil to air, soil to ground water, air to soil, air to surface water, surface water to estuary) and because solutions to one manifestation can exacerbate others
- Create a research agenda that promotes the integration of multiple sources showing interactions, production sources, etc. CEQA may be one way to improve upon the current model – the big answer is communication by bringing together different partners Effect of FDA's Food Safety Modernization Act on N management practices? Ex. Manure/animal waste contributes to health impacts; huge implications for irrigation systems in CA
- Need to evaluate multiple approaches to controlling reactive nitrogen: regulatory, technological, and behavioral, as well as economic effects at the farm and community levels and trade-offs among desired outcomes. For example, we need to understand the food safety implications of capturing and repurposing excess N.
- We need to approach the soil/plants as a holistic system – BUT EPA system is not organized this way, academics is organized into even smaller silos. How to fix the system to match missions to take more holistic approaches to solving these problems.

Regulatory

- Completely different regulatory framework to address environmental issues – a new model for how we do environmental regulation that lets us do a better job!
- Multi-pollutant SIPs
- 80 percent of NO_x in the San Joaquin Valley is from mobile sources under purview of CARB and EPA
- Blend regulatory systems & management/data requirements (combine databases that are useful to the industry)

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- Develop support for growers with respect to nutrient management plans—mechanisms for nutrient reporting and incentives for advances in nutrient stewardship
- Regulatory considerations: options limited by statutes but state is expecting to roll out a new program in the next year or so.

Economic

- Is the focus on highest economic return resulting in the right N application decisions for the environment?

Relative priority

- Safe drinking water is the most pressing issue but need to consider economic and technical feasibility against human health benefit of different solutions; for instance, the decadal time lag between reduction in N inputs and decrease in ground water nitrate contamination makes source control infeasible for providing safe drinking water

Potential benefits

- How do we become less reliant on fossil fuels and better reuse N instead of it becoming a waste product that we have to deal with after the fact?
- How do we re-establish the N cycling using animal/human waste, be less reliant on fossil fuels, and re-use the N that's already there?
- Is there a way to simultaneously look at water and air quality management, particularly waste management systems, through this lens, to maximize N availability and reduce GHG and fossil fuel dependence (i.e. multimedia approach to fertilization management)? Maximize trade-offs, optimize N availability, minimize GHG

Potential consequences

- What is the domino effect of different N regimes (i.e., hotspots in SJV, by altering the valley's agricultural landscape and practices within the valley)? What are the consequences of policies that will alter the current landscape of SJV agriculture – big implications for rest of valley—cascading effects
- Economics in the rural communities needs to be considered
- Practicability of the 1.4 x agronomic rate standard for N applications is an issue
- Need to consider and account for the salt content of manure as well as N input
- The current nitrate MCL (10 ug/l) will make farming in the SJV impossible
- Need to address conflict between water regulations and food safety requirements, especially in Salinas Valley.